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FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
36290-151370	09/830209

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/03476	October 20, 1999	October 22, 1998

TITLE OF INVENTION
Method and Apparatus For Spraying

APPLICANT(S) FOR DO/EO/US
Jim Lindsay and George Walter Robsinson

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Express Mail Lable No. EL 740326013 US

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/830209	PCT/GB99/03476	36290-151370

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1000.00
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$860.00
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$710.00
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$690.00
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	32 - 20 =	12	x $18.00	$216.00	
Independent claims	3 - 3 =	0	x $80.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$1,076.00	
☒ Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				$538.00	
SUBTOTAL =				$538.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$0.00	
TOTAL NATIONAL FEE =				$538.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				$0.00	
TOTAL FEES ENCLOSED =				$538.00	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$538.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **50-0573** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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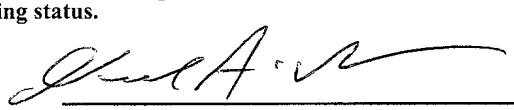
PATENT TRADEMARK OFFICE



SIGNATURE

Daniel A. Monaco

NAME

30,480

REGISTRATION NUMBER

April 20, 2001

DATE

PATENT

Attorney Docket No.: 36290-151370

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Patent application of Jim Lindsay and George Walter Robinson.	:	
		:	Group Art Unit:
Serial No.:	Not Yet Assigned	:	Not Yet Assigned
(International Serial No. PCT/GB99/03476)		:	
Filed:	Concurrently Herewith	:	Examiner:
(International Filing Date: October 20, 1999)		:	Not Yet Assigned
For:	Method and Apparatus For Spraying	:	

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Kindly amend the above-identified patent application, without prejudice, as follows.

In the Claims:

Amend claims 3, 4, 6, 7, 11, 15, 16, 17, 18, 19, 22, 23, 24 and 28 as follows. A mark-up of the amended claims as required by 37 C.F.R. 1.211(c)(ii) is attached hereto as Appendix A.

CERTIFICATE OF MAILING
UNDER 37 C.F.R. 1.10

EXPRESS MAIL Mailing Label Number: EL 740326013
Date of Deposit: April 20, 2001
I hereby certify that this correspondence, along with any paper referred to as being attached or enclosed, and/or fee, is being deposited with the United States Postal Service, "EXPRESS MAIL–POST OFFICE TO ADDRESSEE" service under 37 CFR 1.10, on the date indicated above, and addressed to: Commissioner for Patents, Washington, D.C. 20231.

Signature of person mailing page:

Therese McKinley
Type or print name of person

3. (Amended) An apparatus according to Claim 1, wherein said second passageway is substantially conical in shape.

4. (Amended) An apparatus according to Claim 1, wherein said second passageway includes an inlet and an outlet, wherein said second passageway is tapered from said inlet to said outlet.

6. (Amended) An apparatus according to Claim 4, wherein said second passageway has a radius of curvature at said outlet so as to provide gas to the outlet nozzle in a substantially horizontal direction.

7. (Twice Amended) An apparatus according to Claim 1, wherein said stepped portion of said second passageway comprises a ledge whose width tapers up to maximum of 10% of the radius if said second passageway at the level of the stepped portion.

11. (Twice Amended) An apparatus according to Claim 10 any preceding claim, further comprising a trigger means;

whereby said trigger means is adapted to operate both of said control valve and said gas valve.

15. (Twice Amended) An apparatus according to either Claim 13, wherein said piston valve produces an annular air jet in said second passageway.

16. (Twice Amended) An apparatus according to Claim 13, further comprising an air control valve stem which is connected to said piston valve and operated by said trigger means.

17. (Twice Amended) An apparatus according to Claim 13, supplied with a liquid by said gravity liquid reservoir.

18. (Amended) An apparatus according to Claim 12, wherein the liquid control needle valve is controlled by said trigger means via an axially-sliding sleeve or slipper member situated on a rearward portion of said housing.

19. (Amended) An apparatus according to Claim 12, wherein said liquid control needle valve is provided with a rotational flow adjustment means.

22. (Amended) An apparatus according to Claim 12, wherein said liquid inlet comprises a pressurized material supply connector, and wherein said needle valve is supplied with a liquid by said pressurized material supply connector.

23. (Amended) an apparatus according to Claim 12, wherein said liquid inlet comprises a gravity feed liquid reservoir, and wherein said needle valve is supplied with a liquid by said gravity liquid reservoir.

24. (Amended) An apparatus according to Claim 10, further comprising a regulating valve and a pair of side jets, whereby the spray pattern of the outlet nozzle is regulated by said regulating valve, and said side jets are utlilised to regulate said spray pattern.

28. (Amended) A method according to Claim 25, wherein the mixing of said liquid and said annular gas jet is controlled by a trigger valve mechanism on said spray apparatus.

REMARKS

Claims 1-34 are pending in the application. The claims have been amended to reduce dependencies to decrease the filing fee.

Respectfully submitted,

JIM LINDSAY et al.

BY: _____

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APPENDIX A - "Marked-up" Versions of Amended Claims as Required Under 37 C.F.R. 1.121(c)(1)(ii)

3. (Amended) An apparatus according to [either] Claim 1 [or Claim 2], wherein said second passageway is substantially conical in shape.

4. (Amended) An apparatus according to Claim 1 [any preceding claims], wherein said second passageway includes an inlet and an outlet, wherein said second passageway is tapered from said inlet to said outlet.

6. (Amended) An apparatus according to [either] Claim 4 [or Claim 5], wherein said second passageway has a radius of curvature at said outlet so as to provide gas to the outlet nozzle in a substantially horizontal direction.

7. (Amended) An apparatus according to Claim 1 [any preceding claim], wherein said stepped portion of said second passageway comprises a ledge whose width tapers up to maximum of 10% of the radius if said second passageway at the level of the stepped portion.

11. (Amended) An apparatus according to Claim 10 [any preceding claim], further comprising a trigger means;

whereby said trigger means is adapted to operate both of said control valve and said gas valve.15. (Twice Amended) An apparatus according to either Claim 13 [or Claim 14], wherein said piston valve produces an annular air jet in said second passageway.

16. (Amended) An apparatus according to [any of Claims] Claim 13 [to 15], further comprising an air control valve stem which is connected to said piston valve and operated by said trigger means.

17. (Amended) An apparatus according to [any of Claims] Claim 13 [to 16],supplied with a liquid by said gravity liquid reservoir.

18. (Amended) an apparatus according to [any of Claims] Claim 12 [to 17], wherein the liquid control needle valve is controlled by said trigger means via an axially-sliding sleeve or slipper member situated on a rearward portion of said housing.

19. (Amended) An apparatus according to [any of Claims] Claim 12 [to 18], wherein said liquid control needle valve is provided with a rotational flow adjustment means.

22. (Amended) An apparatus according to [any of Claims] Claim 12 [to 21], wherein said liquid inlet comprises a pressurized material supply connector, and wherein said needle valve is supplied with a liquid by said pressurized material supply connector.

23. (Amended) an apparatus according to [any of Claims] Claim 12 [to 21], wherein said liquid inlet comprises a gravity feed liquid reservoir, and wherein said needle valve is supplied with a liquid by said gravity liquid reservoir.

28. (Amended) A method according to [any of Claims] Claim 25 [to 27], wherein the mixing of said liquid and said annular gas jet is controlled by a trigger valve mechanism on said spray apparatus.

24. (Amended) An apparatus according to Claim 10 [any preceding claim], further comprising a regulating valve and a pair of side jets, whereby the spray pattern of the outlet nozzle is regulated by said regulating valve, and said side jets are utlilised to regulate said spray pattern.

METHOD AND APPARATUS FOR SPRAYING

The present invention relates to a method and apparatus for low air pressure spraying. Particularly, but not exclusively, the invention is applicable to spray guns for the application of paint and like material surface treatments, particularly water-based paints.

The use of spray guns for application of paints is well known. However, it has been found that when water-based, high gloss paints are sprayed through a high pressure or conventional spray gun, the level of gloss is reduced. This is also true of the high volume-low pressure type of spray gun which operate at only 10psi air cap pressure.

Tests carried out at various pressures have shown that the loss of gloss is due to air bubbles rising to the surface of the paint as it dries. It has been found that the greater the pressure used to spray the paint, the more air bubbles appear. The cause of the bubbles is that dissolved air is being released from the water as the paint dries. The greater the air pressure when the paint is sprayed, the greater the volume of dissolved air and the greater the number of bubbles.

If the air pressure is low but the volume is high, gloss levels are reduced. To achieve the desired gloss levels with this type of paint it is necessary to design a spray gun that will operate at very low air pressures and very low air volumes. It must achieve acceptable levels of atomization, have sufficient energy to transfer the paint at an acceptable rate to the surface of the target, and expand the natural cone of spray into a useful fan pattern.

In the past, spray guns have used air pressures between 40 and 90 psi, and these high pressures cause a cushion of air to be formed on the surface of the product being treated. This cushion causes some of the sprayed material to bounce back and be displaced laterally by the following airflow to be lost in the surrounding air.

Accordingly, this type of spray gun is very inefficient. Rarely are transfer efficiencies greater than 40% and more often nearer 30%. The waste paint material produces unacceptable emissions of volatile organic compounds and leaves a solid residue which can remain floating in the air for some time. These can be highly toxic and damaging to the atmosphere and health. To overcome these problems, it is necessary to reduce the air pressure and air volume used in such guns. Therefore, the environmental requirements for an acceptable spray gun are similar to those required for achieving a good gloss in water-based paints.

If the air pressure is reduced on a spray gun that was originally designed for high pressure use, the turbulence and restrictions in internal air passages and the air cap cause a loss of air speed and a reduction in air volume. The result of this is low

paint transfer rates, poor atomization and an inferior paint finish. However, transfer efficiency is improved. If the air volume is increased while keeping the pressure low, the ratio of air to paint increases and the problems experienced with high pressure will return depending on the increase in volume.

Existing high pressure spray guns have been modified to operate at low pressures, but the complexity of the designs and the intricate interconnecting drilled passages do not permit good air flow. In an effort to overcome the poor performance, air cap ring gaps were increased, resulting in a substantial increase in air consumption. This type of spray gun has become known as the high volume-low pressure (HVLP) gun.

More specifically, in HVLP spray guns the means for actuating the control valves within the gun have had considerable shortcomings. For example, it is commonplace for the stem of the needle valve and its associated compression spring and housing to extend through the main air flow passage to the nozzle, thereby leading to significant restrictions in the air flow path.

Likewise, in order to provide a convenient means for actuating the stem of the air flow and fluid needle valves, the main nozzle of the apparatus is mounted on a forward projection of the apparatus so as to leave a free space to accommodate the arc of movement of the valve control trigger.

Moreover, since the same trigger operates both the liquid and air control valves, the progressive control from on to off operating characteristics of the air control valve can be restricted in certain operating

conditions where the liquid control valve has been manually adjusted to such a point that it affects the ability of the trigger to operate both valves simultaneously through the full range of movement.

The object of the present invention is to provide a method and apparatus for spraying paint and other surface treatment liquids, offering improvements in relation to one or more of the matters discussed above, or generally.

According to a first aspect of the invention there is provided an apparatus for spraying liquid surface treatment material, said apparatus having a housing, a liquid inlet for supply of the liquid surface treatment material, a gas inlet for supply of pressurised gas to be mixed with the liquid surface treatment material, an outlet nozzle through which the gas and liquid surface treatment material is sprayed, a control valve adapted to regulate the supply of the liquid surface treatment material to the outlet nozzle, a gas valve operable between an open position and a closed position, a first communicating passageway connecting said gas inlet to said gas valve, and a second communicating passageway connecting said gas valve to said outlet nozzle; wherein said second passageway is provided with a stepped portion therein so that a gas vortex is created therethrough.

Preferably, said second passageway is offset from said first passageway. Preferably, said second passageway is substantially conical in shape. Preferably, said second passageway includes an inlet and an outlet, wherein said passageway is tapered from said inlet to said outlet. Preferably, said taper is between 1 and 15°.

Preferably, said stepped portion of said second passageway comprises a ledge whose width tapers up to a maximum of 10% of the radius of said second passageway at the level of the stepped portion.

Preferably, said second passageway has a radius of curvature at said outlet so as to provide gas to the nozzle in a substantially horizontal direction.

Preferably, the longitudinal axis of said outlet nozzle extends across said second passageway. Preferably, the axis of symmetry of said ledge is offset from said longitudinal axis of said outlet nozzle, thereby inducing a vortex in the air flowing through said passageway.

According to a second aspect of the invention there is provided an apparatus for spraying liquid surface treatment material, said apparatus having a housing, a liquid inlet for supply of the liquid surface treatment material, a gas inlet for supply of pressurised gas to be mixed with the liquid surface treatment material, an outlet nozzle through which the gas and liquid surface treatment material is sprayed, a control valve adapted to regulate the supply of the liquid surface treatment material to the outlet nozzle, a gas valve operable between an open position and a closed position, a first communicating passageway connecting said gas inlet to said gas valve, and a second communicating passageway connecting said gas valve to said outlet nozzle; wherein said second passageway is axially offset from said first passageway and is substantially conical in shape, and wherein said second passageway includes an inlet and an outlet and is tapered from said inlet to said outlet at an angle of taper of between 1 and 15°.

Preferably the apparatus further comprises a trigger means, whereby said trigger means is adapted to operate both of said control valve and said gas valve.

Preferably, said gas valve is an axially-sliding piston valve. Preferably, said control valve is a liquid control needle valve.

Preferably, said outlet nozzle is controlled by said liquid control needle valve.

Preferably, said piston valve produces an annular air jet in said second passageway. The piston valve may be tapered or parallel. In addition, an air control valve stem is provided which is connected to the piston valve and operated by said trigger means.

Preferably, said piston valve comprises inner and outer co-axial apertured sleeves, wherein said inner sleeve is located within said outer sleeve and is rotatably adjustable relative to said outer sleeve.

Preferably, the liquid control needle valve is controlled by said trigger means via an axially-sliding sleeve or slipper member situated on a rearward portion of the housing. Preferably, it is also provided with a rotational flow adjustment means to adjust the flow rate of the liquid.

Preferably, said flow adjustment means comprises a stem member, a rotational adjuster, and a return spring, said stem member being threaded at its rearmost extremity to accept the rotational adjuster. Preferably, said stem member is actuated externally by the trigger means, and is returned to its initial position by a return spring.

Preferably, the apparatus further comprises a regulating valve and a pair of side jets, whereby the spray pattern of the outlet nozzle is regulated by said regulating valve, and said side jets are utilised to regulate said spray pattern.

Preferably, the needle valve is supplied with the paint or material surface treatment liquid by a pressurized material supply connector which distributes the material via a radial port to said needle valve. Alternatively, the material may be introduced to the apparatus from a gravity liquid reservoir fitted to the uppermost aspect of the apparatus via a radial port.

According to a third aspect of the present invention, there is provided a method of spraying a fluid onto a surface, said method comprising the steps of:

supplying a liquid to be sprayed into a liquid inlet of a spray apparatus;

supplying a pressurised gaseous propellant into a gas inlet of said spray apparatus;

passing said gaseous propellant through a communicating passageway from said gas inlet to an outlet nozzle;

accelerating said gaseous propellant by creating a gas vortex as said propellant passes through said communicating passageway;

passing said accelerated propellant through an outwardly tapering portion of the communicating passageway to further accelerate the vortex and supply the propellant to the outlet nozzle in the form of an annular gas jet; and

spraying said liquid onto a surface by mixing said liquid and said annular gas jet at said nozzle.

Preferably, said passageway comprises an upper portion

and a lower portion, wherein said upper portion is axially offset from said lower portion and is substantially conical in shape. Preferably, said upper portion of said passageway includes an inlet and an outlet and is tapered from said inlet to said outlet at an angle of taper of between 1 and 15°.

Preferably, the mixing of said liquid and said annular gas jet is controlled by a trigger valve mechanism on said spray apparatus. Preferably, said trigger valve mechanism comprises:

a gas valve operable between an open position and a closed position;

a control valve adapted to regulate the supply of the liquid to be sprayed; and

a trigger means;

whereby said trigger means is adapted to operate both of said gas and control valves.

Preferably, said control valve is a liquid control needle valve. Preferably, said gas valve is an axially-sliding piston valve. Preferably said piston valve comprises an inner apertured sleeve and an outer apertured sleeve, said inner and outer sleeves being co-axial, and wherein said inner sleeve is located within said outer sleeve and is rotatably adjustable relative to said outer sleeve.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which :-

Figure 1 shows a first embodiment of a spray gun according to the present invention;

Figure 2 shows a section through the spray gun of

Figure 1 having pressure feed and offset air passages;

Figure 3 shows a second embodiment of a spray gun according to the present invention;

Figure 4(a) shows a section through the spray gun of Figure 3 having offset air passages and a tapered upper air passage;

Figure 4(b) is a sectional view along line "A-A" of Figure 4(a);

Figure 4(c) is a sectional view along line "B-B" of Figure 4(a), showing the stepped portion of the upper air passage;

Figure 5 shows a third embodiment of a spray gun according to the present invention;

Figure 6(a) shows a section through the spray gun of Figure 5;

Figure 6(b) shows the component parts of the piston valve of the spray gun of Figures 5 and 6(a); and

Figure 6(c) shows a sectional view along line "VI-VI" of Figure 6(a).

As shown in Fig 1, a first embodiment of a spray apparatus 10 comprises a body or housing 12 having a nozzle 14, an operating trigger 40, and a regulating valve 52. Nozzle 14 is secured to the housing 12 by a threaded ring 11.

Figure 2 shows a section view through the spray gun which shows the components of the apparatus 10 in more

46, thereby opening the needle valve 22 to allow liquid to pass through.

A regulating valve 52 is positioned whereby the jet 15 produced by nozzle 14 is regulated from a natural cone to a fan pattern by air from side jets 17.

The air passage 38 connects the air supply connection 16 with the piston valve 23. The air control valve stem 20 controls the air flow through a pair of offset passages 38 and 39, where the lower passage 38 and the upper passage 39 are offset to create a vortex within the upper passage 39, thereby accelerating the gas flow through said upper passage 39. A return spring 25 is also provided in order to return the piston 24 and stem 20 to their extended position when released. The piston valve 23 has two apertured rotational sleeves 26 which can be adjusted by a lever 21 to either line up, close off or partially close the apertures, thereby increasing or decreasing the vortex in the passage 39. Thus, the pressure in the gun can be regulated to offer variable pressure sprays. A more detailed description of the operation of the piston valve 23 is given later.

The liquid control valve needle 22 has a stem member 42 which passes through sleeve member 46 and is threaded at its rearmost extremity to accept the rotational adjuster 44. The rotational adjuster 44 allows fine position adjustment of the fluid control needle 22. Trigger 40 actuates the needle member 22 externally of the housing 12. An internal return spring (not shown) returns the needle 22 to its rest position. Liquid to be sprayed is fed to the needle valve 22 from connection 18 via a radial port 56.

Figure 3 shows a second embodiment of a spray gun

Thus, the vortex flows through the chamber 51 relatively unhindered by the valve 22 as the gas flows around the outside of the valve 22, and the vortex is not destroyed by the valve 22.

Aside from the amendments to the passage 39, this embodiment of the spray gun 10 is constructed and operated substantially in the same manner as the spray gun 10 of figure 1.

The third and final of the preferred embodiments described is shown in Figures 5 and 6(a)-(c). Again, externally, the spray gun 10 is similar in appearance to the other embodiments, with the majority of the components previously described above being used. However, the third embodiment differs in the operation of the piston valve assembly 23 which produces the vortex.

The use of a pair of apertured sleeves 26a,26b within the piston valve assembly 23 was first discussed in the description of the first embodiment above. However, the individual components of the piston valve assembly 23 are best seen in Figure 6(b). The valve assembly 23 consists of an apertured outer sleeve 26b and an apertured inner sleeve 26a, and each of the sleeves 26a,26b has a pair of apertures 61,62. On each sleeve 26a,26b, the apertures 61,62 are located diametrically opposite one another, thereby permitting gas to pass through the sleeves 26a,26b unhindered.

Figure 6(a) shows the manner in which the various components of the valve assembly 23 co-operate. The inner sleeve 26a is located inside the outer sleeve 26b, with the apertures 61,62 of the two sleeves 26a,26b being axially aligned to allow gas to pass

upper passage 39 of the apparatus 10.

In use, each of the embodiments is operated as follows: The reservoir of material to be sprayed delivers the material to central jet 15 under the control of needle valve 22 where it is mixed with air delivered via air passages 38 and 39. The operation of the gun is initiated by trigger 40 operating air control valve stem 20 and liquid control valve 22.

The present invention provides a method and apparatus for spraying that addresses the limitations and inefficiencies of prior spray guns. As it may operate at pressures as low as 1.5psi in the air cap and at air volumes as low as 4cfm, energy savings are achieved. The very low pressures allow a very high transfer efficiency to be achieved which is an added advantage when used with paints containing volatile organic compounds.

The present invention permits the trigger 40 to operate the air control valve 23 and the fluid control valve 22 simultaneously, without restricting the operation of either, regardless of the adjustment of the other. The stems of both the fluid control needle valve 22 and air control piston valve 23 operate in parallel to each other, yet independently of each other.

The above permits a straight, unobstructed, large diameter air passage 38 to the air valve 23 while also permitting a short, straight air passage 39 to the air cap 52 and a large diameter fluid passage.

In addition, by offsetting the air passages 38,39, gas acceleration may be achieved by means of a vortex created by the gas passing through these passages

Air volume required is approximately 50% lower than the average of the representative selection.

Depression at the fluid nozzle is approximately 30% greater than the representative selection.

These and other improvements and modifications can be incorporated without departing from the scope of the invention.

CLAIMS:

1. An apparatus for spraying liquid surface treatment material, said apparatus comprising:

a housing;

a liquid inlet for supply of the liquid surface treatment material;

a gas inlet for supply of pressurised gas to be mixed with the liquid surface treatment material;

an outlet nozzle through which the gas and liquid surface treatment material is sprayed;

a control valve adapted to regulate the supply of the liquid surface treatment material to the outlet nozzle;

a gas valve operable between an open position and a closed position;

a first communicating passageway connecting said gas inlet to said gas valve; and

a second communicating passageway connecting said gas valve to said outlet nozzle;

wherein said second passageway is provided with a stepped portion therein so that a gas vortex is created therethrough.

2. An apparatus according to Claim 1, wherein said second passageway is offset from said first passageway.

3. An apparatus according to either Claim 1 or Claim 2, wherein said second passageway is substantially conical in shape.

4. An apparatus according to any preceding claim, wherein said second passageway includes an inlet and an outlet, wherein said second passageway is tapered from said inlet to said outlet.

5. An apparatus according to Claim 4, wherein said taper is between 1 to 15°.

6. An apparatus according to either Claim 4 or Claim 5, wherein said second passageway has a radius of curvature at said outlet so as to provide gas to the outlet nozzle in a substantially horizontal direction.

7. An apparatus according to any preceding claim, wherein said stepped portion of said second passageway comprises a ledge whose width tapers up to a maximum of 10% of the radius of said second passageway at the level of the stepped portion.

8. An apparatus according to Claim 7, wherein the longitudinal axis of said outlet nozzle extends across said second passageway.

9. An apparatus according to Claim 8, wherein the axis of symmetry of said ledge is offset from said longitudinal axis of said outlet nozzle.

10. An apparatus for spraying liquid surface treatment material, said apparatus comprising:

a housing;

a liquid inlet for supply of the liquid surface treatment material;

a gas inlet for supply of pressurised gas to be mixed with the liquid surface treatment material;

an outlet nozzle through which the gas and liquid surface treatment material is sprayed;

a control valve adapted to regulate the supply of the liquid surface treatment material to the outlet nozzle;

a gas valve operable between an open position and a closed position;

a first communicating passageway connecting said gas inlet to said gas valve; and

a second communicating passageway connecting said gas valve to said outlet nozzle;

wherein said second passageway is axially offset from said first passageway and is substantially conical in shape, and wherein said second passageway includes an inlet and an outlet and outwardly tapers from said inlet to said outlet at an angle of taper of between 1 and 15°.

11. An apparatus according to any preceding claim, further comprising a trigger means;

whereby said trigger means is adapted to operate both of said control valve and said gas valve.

12. An apparatus according to Claim 11, wherein said control valve is a liquid control needle valve.

13. An apparatus according to Claim 12, wherein said gas valve is an axially-sliding piston valve.

14. An apparatus according to Claim 13, wherein said outlet nozzle is controlled by said liquid control needle valve.

15. An apparatus according to either Claim 13 or Claim 14, wherein said piston valve produces an annular air jet in said second passageway.

16. An apparatus according to any of Claims 13 to 15, further comprising an air control valve stem which is connected to said piston valve and operated by said trigger means.

17. An apparatus according to any of Claims 13 to 16,

wherein said piston valve comprises an inner apertured sleeve and an outer apertured sleeve, said inner and outer sleeves being co-axial, and wherein said inner sleeve is located within said outer sleeve and is rotatably adjustable relative to said outer sleeve.

18. An apparatus according to any of Claims 12 to 17, wherein the liquid control needle valve is controlled by said trigger means via an axially-sliding sleeve or slipper member situated on a rearward portion of said housing.

19. An apparatus according to any of Claims 12 to 18, wherein said liquid control needle valve is provided with a rotational flow adjustment means.

20. An apparatus according to Claim 19, wherein said flow adjustment means comprises a stem member, a rotational adjuster, and a return spring, said stem member being threaded at its rearmost extremity to accept said rotational adjuster.

21. An apparatus according to Claim 20, wherein said stem member is actuated externally by said trigger means, and is returned to its initial position by said return spring.

22. An apparatus according to any of Claims 12 to 21, wherein said liquid inlet comprises a pressurized material supply connector, and wherein said needle valve is supplied with a liquid by said pressurized material supply connector.

23. An apparatus according to any of Claims 12 to 21, wherein said liquid inlet comprises a gravity feed liquid reservoir, and wherein said needle valve is

portion of said passageway includes an inlet and an outlet and is tapered from said inlet to said outlet at an angle of taper of between 1 and 15°.

28. A method according to any of Claims 25 to 27, wherein the mixing of said liquid and said annular gas jet is controlled by a trigger valve mechanism on said spray apparatus.

29. A method according to Claim 28, wherein said trigger valve mechanism comprises:

a gas valve operable between an open position and a closed position;

a control valve adapted to regulate the supply of the liquid to be sprayed; and

a trigger means;

whereby said trigger means is adapted to operate both of said gas and control valves.

30. A method according to Claim 29, wherein said control valve is a liquid control needle valve.

31. A method according to Claim 30, wherein said gas valve is an axially-sliding piston valve.

32. A method according to Claim 31, wherein said piston valve comprises an inner apertured sleeve and an outer apertured sleeve, said inner and outer sleeves being co-axial, and wherein said inner sleeve is located within said outer sleeve and is rotatably adjustable relative to said outer sleeve.

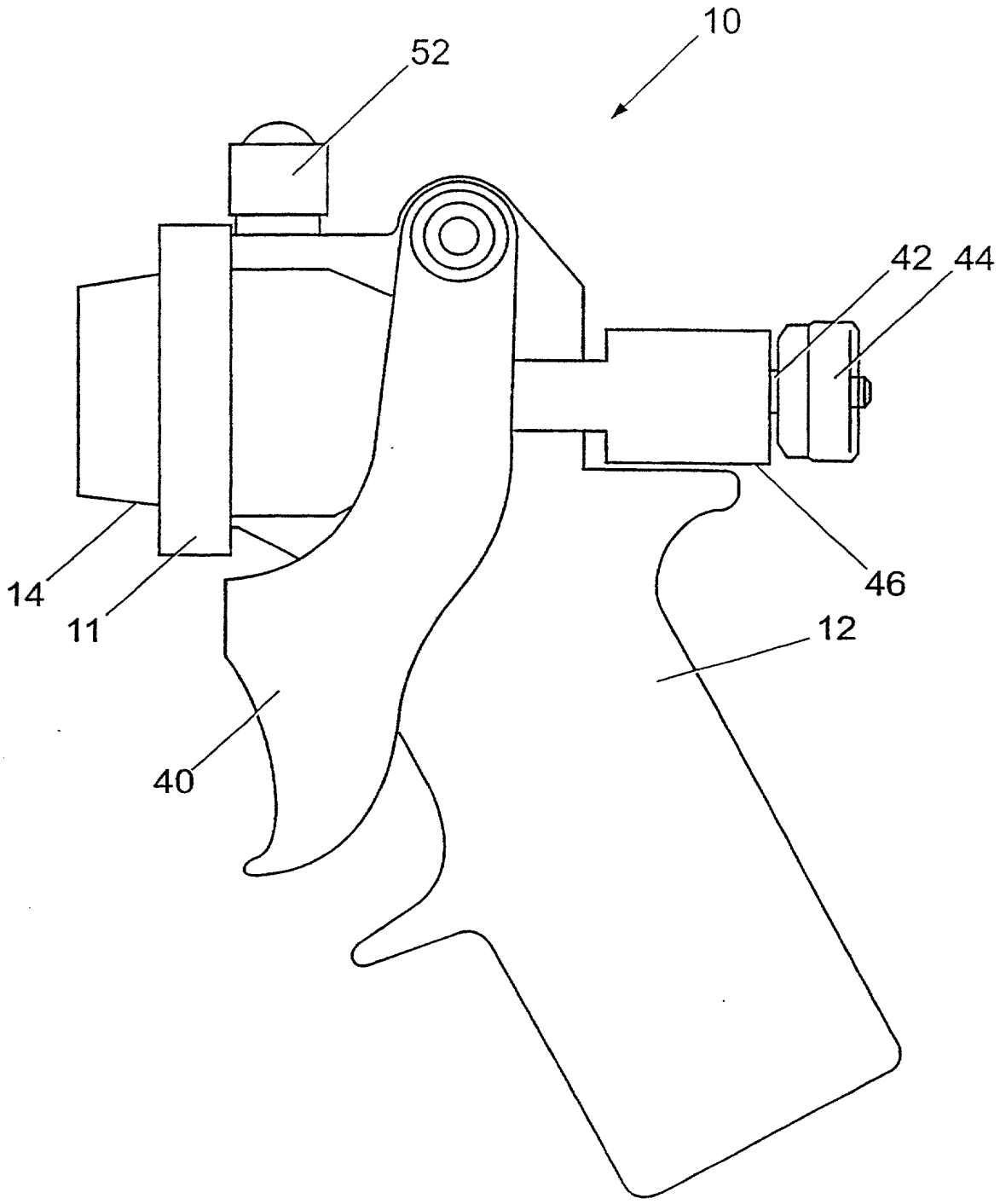

Fig. 1

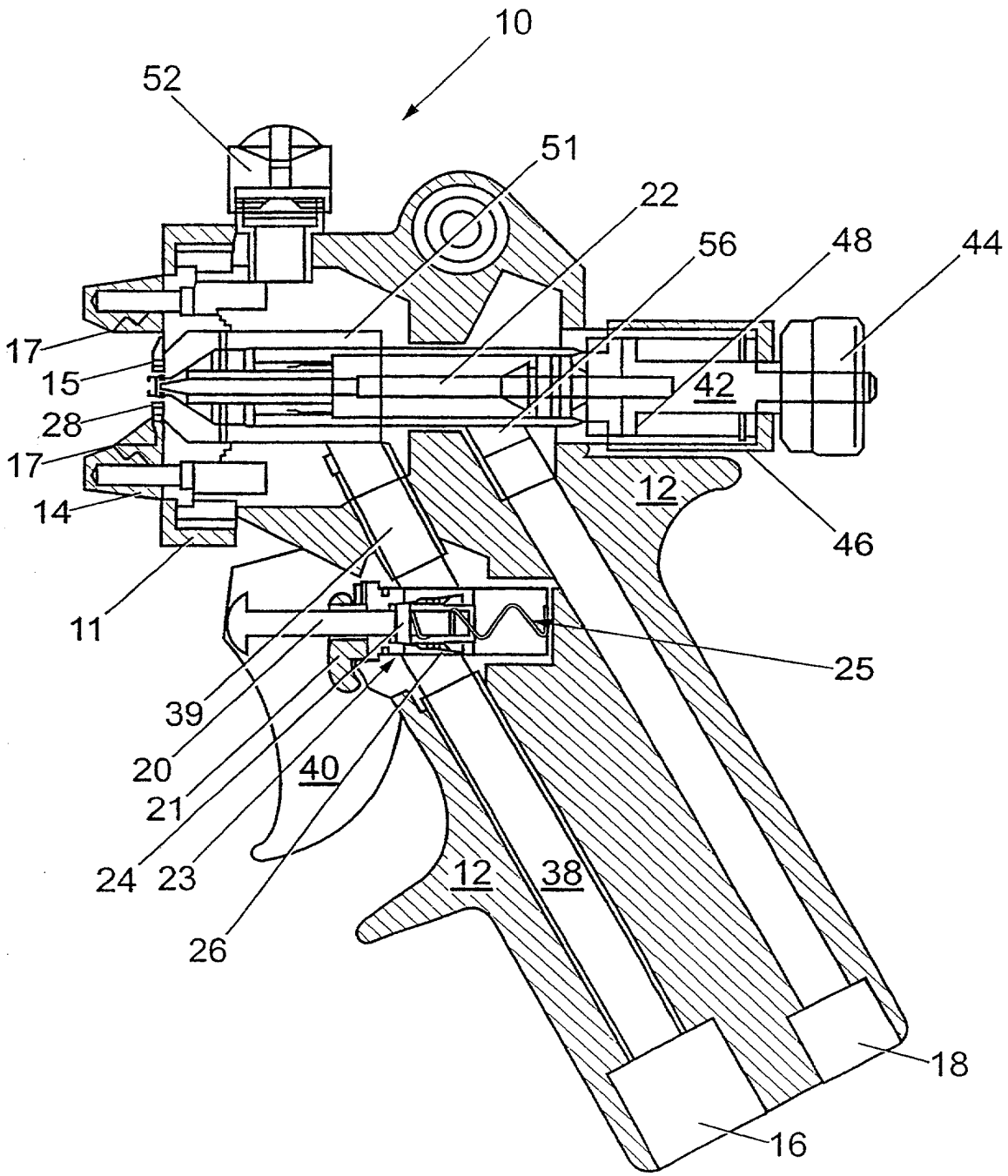
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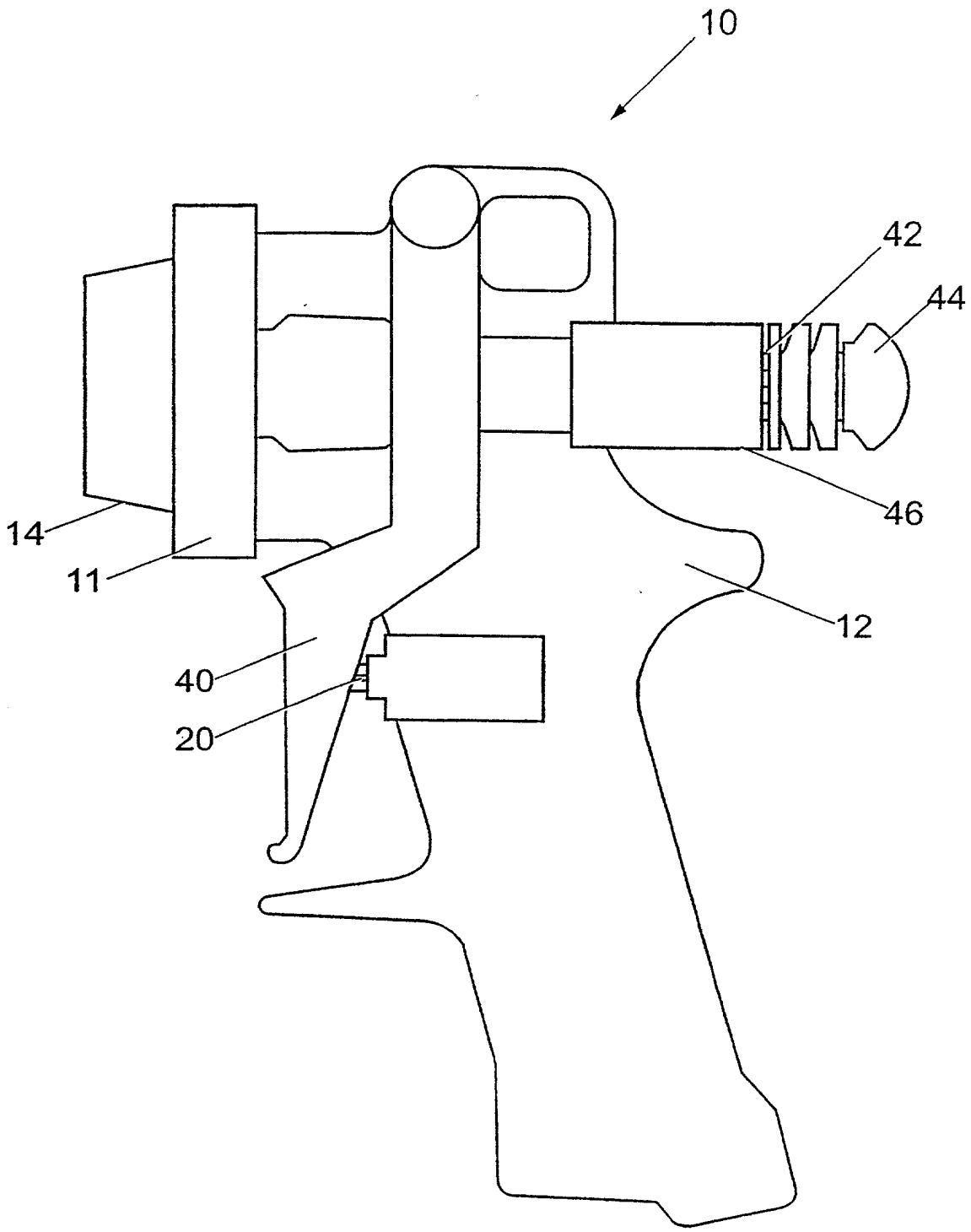
Fig. 2



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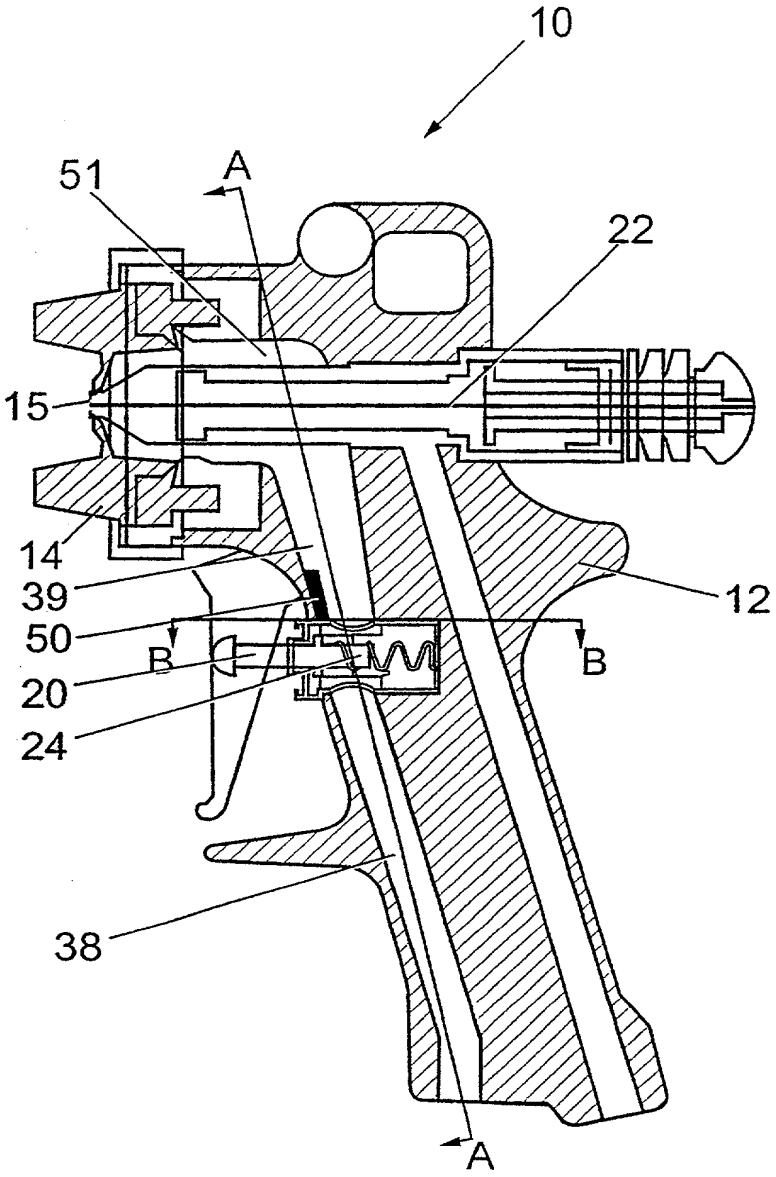
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Fig. 4a

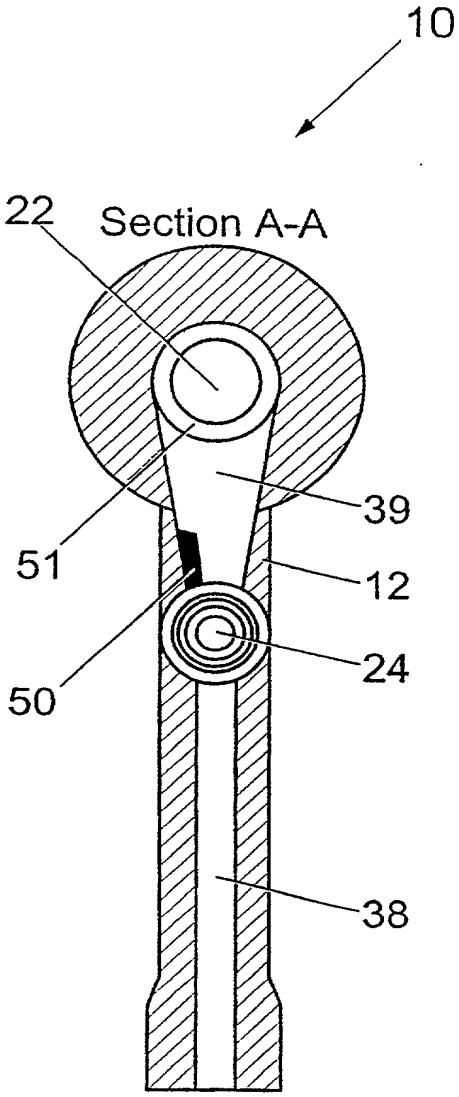
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Fig. 4b

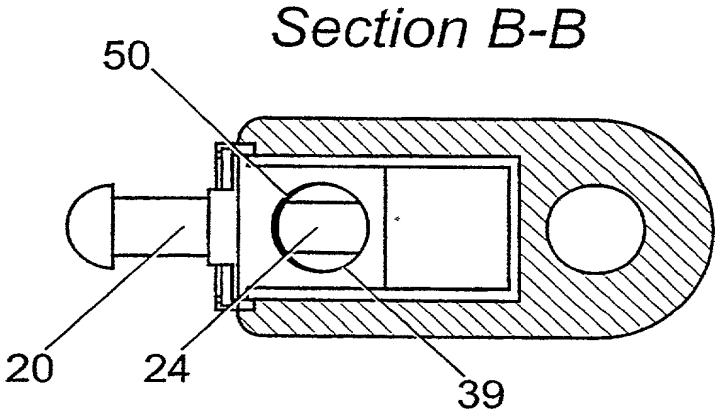

Fig. 4c

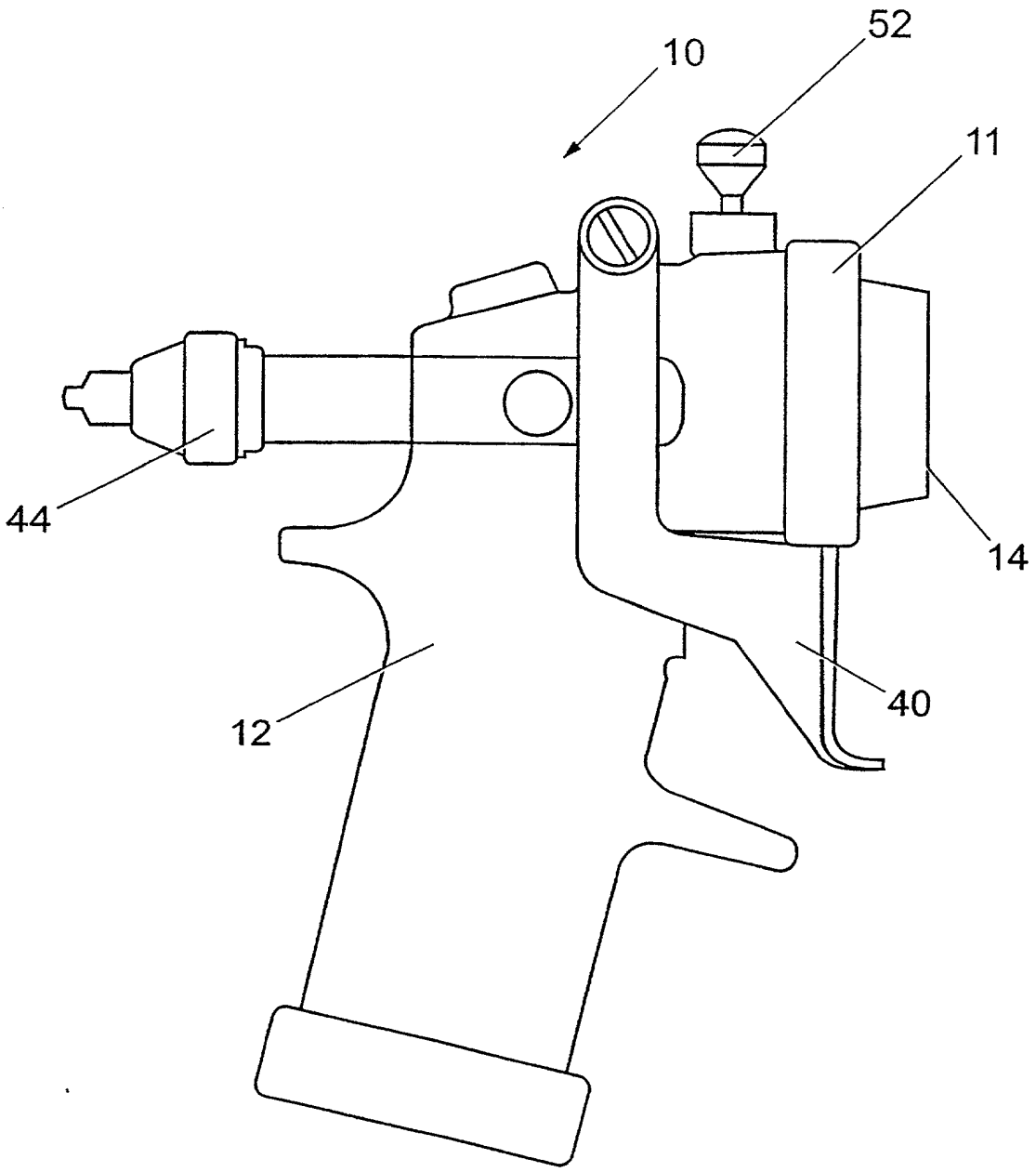

Fig. 5

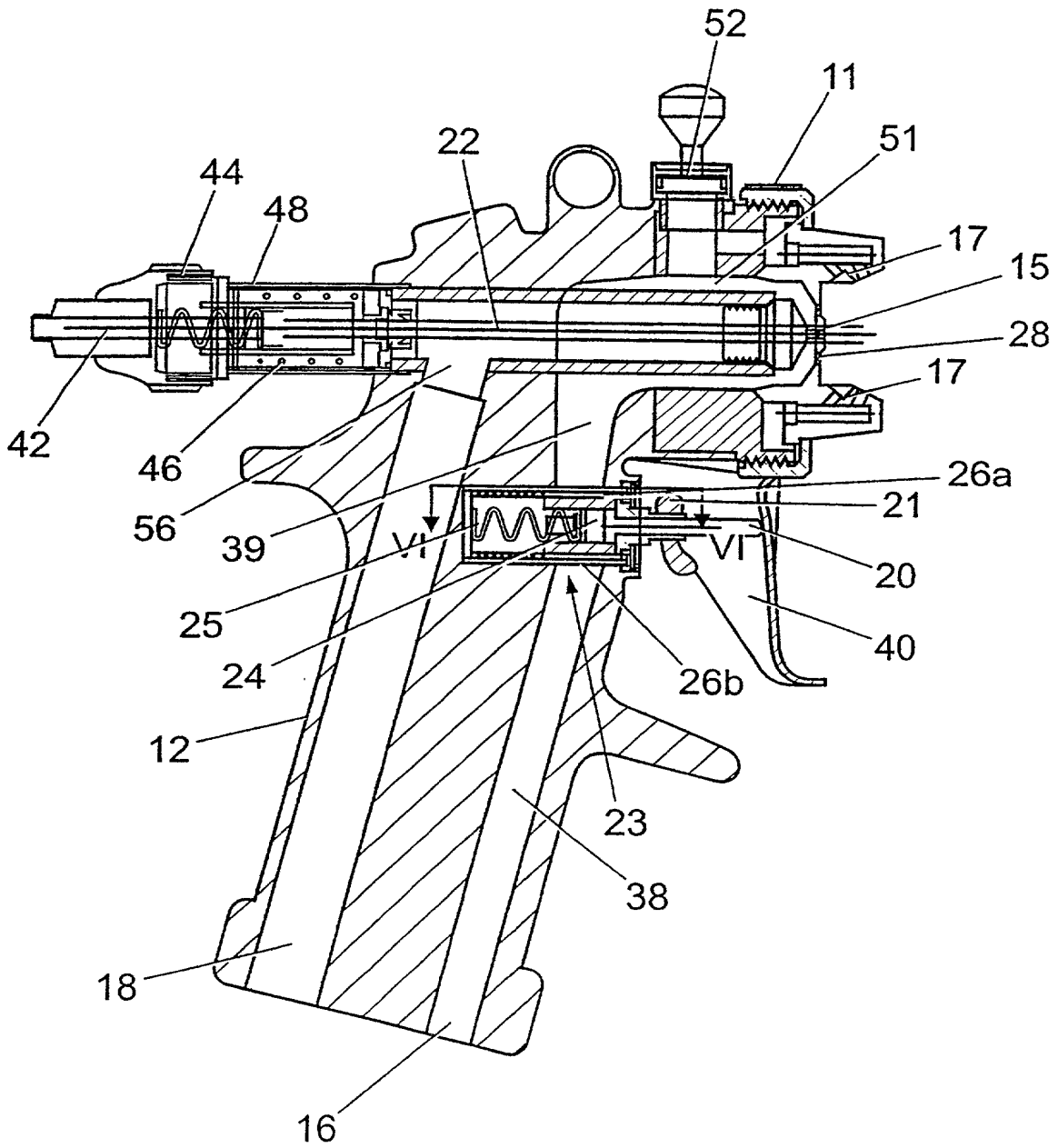
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Fig. 6a

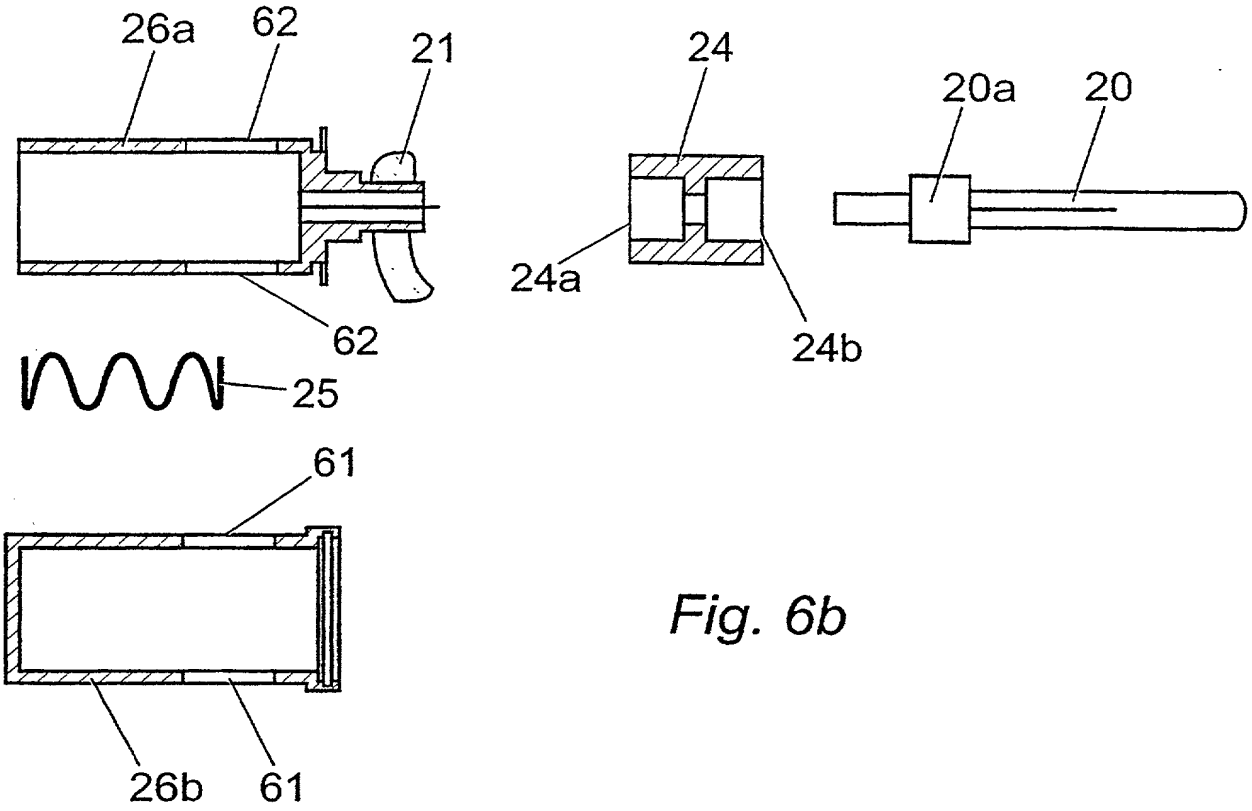
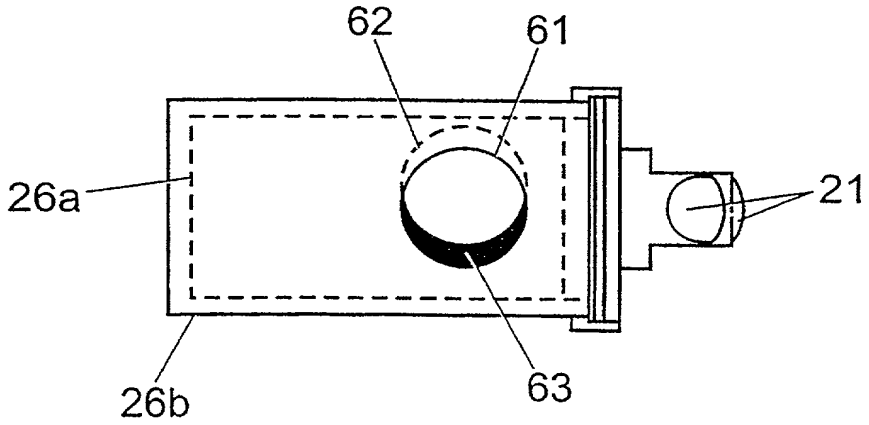


Fig. 6b



Section VI - VI

Fig. 6c

PATENT
Attorney Docket No. 36290-151384

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name:

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR SPRAYING

---

the specification of which is attached hereto unless the following box is checked

☒ was filed on October 20, 1999 as Application No. _____ or PCT Application No. PCT/GB99/03476 and amended on

April 20, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)

COUNTRY/OFFICE	APPLICATION NO.	DATE OF FILING	PRIORITY CLAIMED
GB	9823032.9	October 22, 1998	☒YES NO ☐

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

PROVISIONAL APPLICATION NUMBER	DATE OF FILING

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365(c) of any PCT International application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 25 U.S.C. §120

		Status (check one)		
Application Serial No.	**Date of Filing**	**Patented**	**Pending**	**Abandoned**
		☐	☐	☐

And I hereby appoint Arthur H. Seidel, Registration No. 15,979; Gregory J. Lavorgna, Registration No. 30,469; Daniel A. Monaco, Registration No. 30,480; Thomas J. Durling, Registration No. 31,349; John J. Marshall, Registration No. 29,671; Joseph R. Delmaster, Jr., Registration No. 38,399 and Robert E. Cannuscio, Registration No. 36,469, my attorneys or agents with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1 of 2

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